28. Nov 2018

Mathew Hussey
Office of Engineering and Technology
445 12th Street, Room 7-A162
Washington, DC 20554
VIA ELECTRONIC DELIVERY

RE: Public Notice DA-18-1111A1, ET Docket 13-49
Office of engineering and Technology Requests Comment on Phase I Testing of Prototype U-NII-4 Devices

Dear Mr. Hussey:

1. Introduction

I write in regard to the above-captioned proceeding on behalf of Autotalks, a leading international designer/manufacturer of connected car technologies. For over a decade, Autotalks has worked cooperatively with numerous public and private entities to enhance roadway safety through the development and deployment of a standardized, universally-accepted vehicle-to-vehicle (V2V) communications platform predicated primarily on Dedicated Short Range Communications (DSRC) technology. Recently, Autotalks announced support of C-V2X standard on its second-generation chipset, offering configurable dual-mode DSRC/C-V2X operation.

Autotalks welcomes the extensive test report. While lab tests are an essential first step, those are not enough to make a decision that can impact safety of life. Field tests, using vehicles deployed with V2X, vehicle WiFi hotspots, in-vehicle WiFi devices, and WiFi access points are needed to assure that V2X can operate without any interferences. Acceleration of the tests would be desired to support the existing and planned DSRC deployments, and to provide the required certainty for more OEMs to deploy.

In this document, Autotalks comments on the test results, analyzes the viability of spectrum sharing techniques, and describes needed follow-up tests. In addition, the document includes considerations for introduction of new technology, estimation of new technologies ability to sustain interferences from adjacent WiFi. The position of the European Commission is cited respecting its high relevancy and importance.

2. Comments on test report

a. Detect & Vacate is likely to protect DSRC

Autotalks agrees that Detect & Vacate scheme is likely to provide protection for DSRC operation, but further measurements are needed to fully validate the scheme.

The measured Channel-Move Time at -94dBm exhibits very high delay (>560mS in Table 22 and >220mS in Table 23). Additional measurements, at SAE 2945/1 sensitivity level (-92dBm) and 3dB higher (-89dBm), should be taken for determining if the high delay is observed only close to the sensitivity threshold, or if it is a consistent problem. It is our expectation that the high Channel-Move Time exists only at the sensitivity point, and the new measurements would exhibit an acceptable low delay.

The measurements are conducted for U-NII-4 for WiFi using BPSK and QAM64 modulations. It would be desired to repeat the testing with QPSK, QAM16 and QAM256 modulations. That would allow to adapt the U-NII-4 for quick DSRC detection. For example, if long detection is consistent in BPSK but not observed in QPSK and higher modulations, then a protection scheme can forbid BPSK usage in U-NII-4.

b. Re-channelization doesn't protect lower and upper DSRC bands

Autotalks disagrees that Re-Channelization protects DSRC operation.

Re-Channelization is declared as viable repeating the following sentence twice (in sections 1.3 and 7.1): "For example, assuming a DSRC transmission at the maximum permissible EIRP level of 33 dBm8 along a 300-meter unobstructed line-of-sight propagation path, the theoretical received power level at a U-NII-4 device will be approximately -65 dBm". But the sentence isn't aligned with DSRC profile, as defined in SAE 2945/1:

- DSRC transmission doesn't reach the maximal permissible EIRP level of 33 dBm. DSRC devices are cost and power sensitive, and RF system attenuation, like cables and connectors, should be considered. The typical transmission power used by OEMs today is 23dBm, as defined in SAE profile and in V2V NPRM, and it is not expected to change.
- 300m is the required communication range for real-world road, and not only for measurements at sterile empty roads. Margins are required for non-line-of-sight operation, where many vehicles, including trucks, are filling the roads. Urban environment exhibits higher attenuation, and assumption of -65dBm received power level is rare.

It is evident that re-channelization doesn't provide sufficient protection.

- Lower channels protection: The co-channel operation of 20MHz DSRC and WiFi suffers from low packet completion rate. Figure 48 teaches that 90% packet completion rate can't be achieved at wide span of energy levels (-88dBm to -68dBm). Since 90% packet completion rate is a fundamental safety requirement, and should be achieved at any condition, then lower channels can't be used for safety.
- Upper channels protection: The upper 10MHz channels suffer from high adjacent channel rejection. The adjacent channel resiliency is varying between the different solutions (-56dBm in figure 17 and -50dBm in figures 14/15). It is worth noting that -92dBm and not -90dBm is the desired DSRC signal level, according to SAE 2945/1 profile. The measurements should be repeated with the correct value. It is expected that the energy creating interference would drop by 2dB.

c. Re-channelization would be further challenged by outdoor access points

Outdoor access point has the potential to create interferences to a large area. Outdoor access point may transmit at maximal permissible EIRP level (33dBm) and it can be placed at high pole for longer communication range. The gain resulted from high antenna placement is significant. For example, according to two-ray model, antenna placed at 10m pole, which is sensible for outdoor access point, would have 16.5dB gain above an antenna placed on a vehicle having 1.5m height. That would increase dramatically the outdoor access point interreference range, and bringing it to several hundred meters. Such a big impact of a single access point risks V2X operation. Autotalks recommends to conduct an actual range measurement of DSRC communication ability in the upper 30MHz in the presence of high-power, high-pole outdoor access point.

d. Potential improvement of re-channelization

For safer DSRC operation, adjacent channel interferences should be lowered. That can be achieved by adding a gap between WiFi and DSRC channels. 20MHz gap would lower the interference level by ~14dB, and roughly decreases the span of interference by 2.2X. The separation can be achieved with a similar scheme to Detect & Vacate, evicting the upper 20MHz in the lower WiFi 40MHz band. However, Detect & Vacate scheme is capable of detecting only 10MHz DSRC channels located in the WiFi band, while out-of-band detection is unreliable. Therefore, even re-channelization scheme would require additional 10MHz channels within the lower 40MHz for DSRC detection for the sake of protecting the upper 30MHz against adjacent channel interference.

Additional protection would be achieved by limiting the emitted power in the U-NII-4 band to 23dBm. Access point interference range would further decrease. That power limitation is desired for Detect & Vacate scheme as well to protect the channels in the lower 40MHz band from adjacent WiFi bands.

3. 7 channels are required for V2X current and future use-cases

Autotalks would like to reiterate again the need for 7 V2X channels spanning over 70MHz. Limiting V2X to 30MHz would limit the current and planned use-cases needed for safe and efficient manned and Automated driving. Over the last 2 years, the industry had shown clear need for channels serving the following use-cases:

- Vehicle awareness: Periodic vehicle status messages (BSM) are sent at 10Hz in the safety channel. No other sensor can provide information about obstructed vehicles and other road-users, such as motorcycles. Accident-free Automated Driving depends on the ability to detect risks in reliable and advanced manner.
- Platooning: High-assurance high-frequency (50Hz) messages are used for coordinating trucks platooning. Truck platooning service was just launched in US, and its financial merits for improving the long-haul transportation in US are expected to further contribute to its popularity. V2X messages are controlling the actuation of the trucks, hence any delay or interference would be intolerable.
- Intersection safety:
    - Smart intersection: Computer vision allows reliable detection of pedestrians in cross roads. Vehicles approaching an intersection may not have a clear view of a crossing pedestrian, hence an alert from intersection can increase awareness.
    - Signal Phase and Timing: One of the greatest weaknesses of Automated Vehicles sensors is the ability to accurately identify the relevant traffic light status and to understand the allowed movements in intersection. SPaT messages are essential for reliable AV operation.
- Cooperative sensing: Road safety will take another great leap when every vehicle will have the full knowledge of any object detected by all other vehicles for ‘see-through’ sensing. Vehicles would create a network of sensors. The specification effort is undergoing in Europe, and expected to reach the roads in the middle of next decade.
- Cooperative maneuvering: Negotiation between road users would increase the efficiency of traffic. For example, two lanes merging into one like a zipper while vehicles are maintaining their speed. Negotiations are performed mostly between Automated Vehicles, thus their growing penetration would increase the need for this use-case.

Each of those 5 use-cases occupy a channel. On top of those 5 channels, control channel and pedestrian safety channel should be reserved. That brings the channel count to 7.

4. Consideration of allowing C-V2X to use the spectrum

C-V2X technology was recently introduced as an alternative to DSRC. At the time of this submission, large-scale field tests haven’t been completed yet to prove the technology scalability and stability.

The European Commission recognizes the insufficient C-V2X maturity, and for the time being, it is expected that only DSRC would be included in the upcoming Delegated Act, specifying the allowed vehicle connectivity in Europe.

The Chinese government selected C-V2X for various reasons.

a. C-V2X isn't protected from WiFi interferences without a guard band

5GAA Ex-Parte submission to FCC from 9/27/2018 includes results of adjacent channel interference test. In slide 13, the interfering WiFi signal is transmitted at 23dBm and is set 40MHz apart from the V2X signal. The measured communication range is shown in slide 14. C-V2X communication range drops from ~1150 meters to ~650 meters.

Back-of-the-envelope calculation can estimate the degradation without the 40MHz gap. DSRC measurement have shown 14dB improvement from adding 20MHz guard. It can be assumed that 40MHz guard decreases impact of adjacent channel by at least 18dB. Without the gap, the interference would grow by 18dB, translating to 2.8X range drop in two-ray model, leaving the communication range at 230 meters, using the same conditions of 5GAA test.

The entire test plan should be repeated for C-V2X before it can be allowed for using the spectrum.

b. Potential protection of C-V2X

As suggested for DSRC re-channelization above, Detect & Vacate can evict WiFi operation close to the V2X band. However, UNII-4 WiFi device manufactures would strongly oppose to implement C-V2X detectors due to their high complexity. Alternative detection option would be adding DSRC channel to indicate existence of C-V2X channel. But that challenges the motivation behind adding C-V2X because the only goal of C-V2X Rel. 14/15 is replacement of DSRC basic functionality.

c. Channel split for C-V2X shouldn't be allowed

Not only that DSRC and C-V2X don't interoperate, they don't even co-exist in the same channel.

Channel split scheme allocates a channel for each technology.

Channel split will be a violation of technology neutrality since it will explicitly determine the technology used in each channel. If technology neutrality is a relevant argument then it should not be applied selectively, and it should prevent from having technology specific channels.

The scarce resource of spectrum would be inefficiently used. For example, if a channel will be reserved for C-V2X Rel. 14/15, on top of the channel used for DSRC safety channel, then 20MHz would be used for basic safety messages instead of the needed 10MHz used today for the exact same purpose.

Furthermore, C-V2X Rel. 16 doesn't co-exist in the same channel with C-V2X Rel. 14/15, so another channel would be needed, on top of DSRC channels having the same functionality (cooperative sensing / cooperative maneuvering).

The duplicated spectrum allocation would severely limit the spectrum availability for V2X and its future usability. As shown before, all 7 channels are needed for DSRC, and channel split would require 14 channels for fulfilling the V2X use-cases. Alternatively, the use-cases would be limited, not allowing fulfilling the potential of V2X.

A similar debate took place in Europe, following 5GAA request, but the industry and regulators were united against such split.

d. Interoperability and backward compatibility are the key requirements for safety communication

Technology neutrality is an important principal in spectrum management. However, safety-of-life should have a greater weight. The efficiency of V2X depends on having a large network of connected vehicles, which grows at a quadratic ratio relative to the percentage of vehicles with V2X. If the vehicles would be divided to two different networks because usage of two different technologies, then both networks would fail reaching its goals.

The basic principles for assuring a single network are interoperability and backward compatibility. Any new technology can be allowed as long as it respects those principles.

e. European Commission view

The European Commission is committed to promote V2X toward vision of zero accidents. The commission faced the exact same dilemma of assuring reliable life-saving V2X operation while maintaining technology neutrality by enabling future technologies. In 11/19/18, as a response to a question in the Parliament, the European Transport Commissioner Ms. Bulc made the following statement[1]:

> The Commission is preparing a Delegated Regulation on Cooperative Intelligent Transport Systems under the ITS Directive[2], enabling vehicles to interact directly with each other and with the road infrastructure and foster a new level of cooperation in traffic management. This measure aims to ensure secure and trusted communications and interoperability of messages for safety-related and traffic management services.
>
> With technology rapidly evolving and the public and private sectors investing substantial amounts into developing and testing C-ITS[3] technologies, there is a risk that, without common rules adopted at the Union level, EU-wide interoperability would not be achieved, thereby delaying the deployment of C-ITS, and losing the multiple benefits for transport and society at large. While standardisation activities are necessary, they alone are not sufficient. To ensure interoperability, EU-wide technical specifications are required, which would guarantee that the applicable EU standards are consistently applied.
>
> In line with the EU Strategy on C-ITS[4], the future Delegated Act would provide for a hybrid communication approach, combining complementary and mature technologies (ITS-G5[5] for short-range and 3G/4G for long-range communications). Should stakeholders wish to make use of new technologies, they would be able to submit their specifications to the Commission, indicating their level of maturity.
>
> If such new technologies would be included in the future Delegated Act once the latter is adopted, they would have to ensure compatibility and interoperability with existing C-ITS stations, already placed in service in accordance with that Act, or define an adequate migration path to ensure continuity of C-ITS services.

The key messages are that common rules are essential, and new technologies, if added, should be compatible and interoperate with existing V2X stations in service. Those messages are applicable to US as well, where deployment of DSRC in vehicles has started and expected to expand, and DSRC infrastructure is already in place, and expansion is ongoing.

---

[1] http://www.europarl.europa.eu/doceo/document/P-8-2018-004883-ASW_EN.html

[2] Directive 2010/40/EU on the framework for the deployment of Intelligent Transport Systems, https://eurlex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32010L0040

[3] C-ITS, or Connected ITS, is the term used in Europe for V2X services

[4] COM(2016)766 - A European strategy on Cooperative Intelligent Transport Systems, a milestone towards cooperative, connected and automated mobility, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2016%3A766%3AFIN

[5] DSRC name in Europe

5. Summary

V2X deployment will significantly enhance traffic safety and efficiency. For that to happen, V2X band should be free from harmful interferences. The document notes that:

- Detect & Vacate is likely to provide sufficient protection, pending some additional missing measurements
- Re-channelization fails to protect DSRC in the co-channel lower 40MHz and in the upper 30MHz from adjacent channel interferences
- Potentially, constraints should be applied on WiFi operation at U-NII-4 for minimizing interferences
- All 7 channels are required for V2X current and future use-cases
- It is expected that C-V2X can't operate properly in presence of U-NII-4. Adding C-V2X protection to WiFi chipsets is more challenging than DSRC protection
- Channel split for C-V2X shouldn't be allowed
- European Commission requires any new technology to be compatible and interoperate with existing V2X stations in service

Autotalks see a need to complete Phases II and III of testing before potentially changing DSRC band rules.

Autotalks develops the three technologies under discussion, DSRC, C-V2X and WiFi. As such, Autotalks would be interested to continue and contribute its knowledge and expertise for this discussion. Autotalks hopes that the discussion would lead to a regulatory certainty that would allow OEMs to continue their DSRC deployment plans, and to additional OEMs to decide to install DSRC, at the earliest possible, for saving lives now.

Yours sincerely

Onn Haran, CTO
Autotalks LTD
Grand Netter building, Kfar Netter 40500, Israel